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Specification and Drawings, as originally filed, with Application for Patent Serial No:  
**2,403,610**, on September 17, 2002, by **PREMIER TECH 2000 LTÉE**, for "Buoyancy  
Flushing Apparatus and Method Thereof".

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**ABSTRACT**

A buoyancy flushing apparatus is disclosed which comprises a reservoir for accumulating liquid, having an inlet for receiving liquid and an outlet chamber recessed in a bottom wall of the reservoir. The outlet chamber includes an outlet for draining liquid out of the reservoir. The apparatus further comprises an outlet valve movable between a down position where liquid accumulates in the reservoir and a raised position where liquid accumulated in the reservoir is flushed out via the outlet. The outlet valve comprises a bottom portion sized and shaped to fit loosely in the outlet chamber when said valve is in the down position; and a float portion topping the bottom portion to move the valve in the raised position by buoyancy when a sufficient amount of liquid is accumulated in the reservoir, thereby providing a passageway for liquid between the bottom wall of the reservoir and the valve leading to the outlet in the outlet chamber to flush liquid out of the reservoir. Guiding means are provided for guiding the outlet valve between the down position and the raised position. The apparatus can be used for applications such as water treatment and irrigation. It could advantageously be used for directing and spreading waste water previously treated in a septic tank to different sanitary treating fields.

## **BUOYANCY FLUSHING APPARATUS AND METHOD THEREOF**

### **FIELD OF THE INVENTION**

The present invention is concerned with a flushing apparatus and a method thereof. The present invention also relates to an apparatus for flushing and distributing  
5 predetermined and adjustable volumes of liquid toward one or several directions or surfaces to be used for applications such as water treatment and irrigation. It could advantageously be used for directing and spreading waste water previously treated in a septic tank to different sanitary treating fields.

### **BACKGROUND OF THE INVENTION**

10 Already known in the prior art, there are the flushing or dosing systems involving a hydraulic event used for example in septic fields, or other systems such as irrigation systems. . These systems use gravity powers to obtain a fast flow of water. Most often, these prior art flushing systems use a float body which floats up on the surface of the  
15 coupling which allows the float to lift as the water level rises in the tank, preventing any water from flowing out of the tank. When the water level is high enough, it overflows into the float body, causing the float to loose buoyancy and sink to the bottom of the tank. This action opens a direct path for the water to flow out of the tank. The water in the float empties, allowing the float to regain buoyancy and float up off the bottom of the  
20 tank. Examples of such flushing systems are given in US 5,290,434 and FR 2,760,030 and FR 2,654,761.

More specifically, US 5,290,434 describes an effluent dosing septic system which comprises a relatively water-tight walled structure capable of accumulating a volume of septic tank effluent; a disposal field dosing system having at least one outlet conduit  
25 having an outlet end and an inlet end; a stand pipe which extends from each of the

outlet conduits towards the top of the structure; a float having a chamber having an opening on an upper surface thereof; at least one feed conduit having an inlet end located within the chamber and an outlet end in operative connection with the inlet end of the outlet conduit; and a jointed coupler which forms the operative connection  
5 between the feed conduit(s) and outlet conduits.

FR 2,760,030 describes a flushing system having a float with a horizontal outlet. The float is attached to an outlet tube. The system is supported by a double, hinged cradle, which rotates around a horizontal axis according to the water level. The position in which water begins to flow is determined by the balance between the thrust produced  
10 by the drainage pipe and the attached float and the total weight of the counterweight. The float is attached to a counterweight with one fixed section, which slides over a rod that ensures that the system returns to a height, cutting off the supply to the outlet pipe.

On its side, FR 2,654,761 describes a pendulous drainage device comprising at least one outlet pipe mounted movably between an upper position and a lower position,  
15 inside a tank supplied with a liquid, and communicating at its lower part with a discharge conduit situated outside the tank. This device is characterised in that the free end of the outlet pipe comprises a buoyancy unit consisting of an annular cell inside which the mouthpiece of the outlet pipe opens.

Also known in the art, there is FR 2,654,758, which describes a pendular device for  
20 flushing and distributing a liquid. This device comprises at least one drain tube mounted so that it can move between a high position and a low position outside a tank fed by a liquid and communicating at its lower part with the inside of the tank through the use of a siphon. The tube is normally held in a high position inclined with respect to the vertical by means of a ballast. The effect of the ballast is cancelled out under the action of the  
25 weight of the liquid filling the tube as the level in the tank gradually rises.

Also known in the prior art, there is FR 2,592,595, which describes a liquid distributor with a hydraulic event involving the gravity energy. The device comprises a source of pressure and a plurality of so-called distribution members downstream of the source of pressure. Each of the distribution members is connected to the source of pressure by at least one discharge tube creating a pressure drop greater than any other pressure drop downstream of the said discharge tube.

Among the drawbacks encountered with the above-mentioned documents, there are the followings. These systems do not provide a great flexibility in relation to the water level fluctuation range that is needed for operating the apparatus and they do not provide a great flexibility for adjusting the mobility of the flushing arm.

Also known in the art, there are systems with siphon. Such a system has the drawback of being easily blocked when operated with wastewater. Furthermore, when these systems are operated with low flow rates, the siphon often does not trigger.

Also known in the art, there are the systems involving the use of pumps. Apart from the fact that these systems require a pump, which is per se a limiting factor, it also has the drawback that pumps consume energy and, need maintenance.

Different liquid distribution systems also exist in the prior art for dividing a low flow of wastewater or effluent into equal quantities for distribution to separate discharge pipes in an absorption field. They are the simple T- or Y-shaped flow dividers commercialised under the trademark ZABEL™ Z200 and that split the flow of water into two flows. Such divider has the drawback of being easily clogged when operated with wastewater.

Also known in the prior art, there are the distribution boxes described in US 6,152,650 or in US 6,112,766. Both these documents disclose a liquid distribution system for distributing effluent from a source of wastewater. The liquid distribution system is contained within a distribution box and includes liquid inlet piping, a ramp system, and

a low capacity liquid flow splitting system, including slots and capillary grooves. A high capacity flow splitting system may also be included. In addition, an adjustment system is incorporated into the liquid distribution system for maintaining the level of the liquid distribution system in the ground. One drawback with those distribution boxes is that their distribution efficiency relies on an almost perfect levelling of the box, which levelling is almost impossible to maintain in practice because of the movement of the soil caused by its packing and the freezing of the soil. Another drawback with those distribution boxes is that because there is no regular hydraulic event occurring as in the systems described above which uses a float, clogging tends to rapidly occur within the structure. Indeed, the hydraulic event helps preventing the biomass from growing onto the structure.

The flushing apparatus of the present invention is distinct from and overcomes several drawbacks of the prior art devices, as will be discussed in detail below.

### SUMMARY OF THE INVENTION

An object of the present invention is to provide a flushing apparatus for liquid that overcomes several of the drawbacks mentioned above.

In accordance with the present invention, that object is achieved with a buoyancy flushing apparatus comprising a reservoir for accumulating liquid. The reservoir has an inlet for receiving liquid and an outlet chamber recessed in a bottom wall of the reservoir. The outlet chamber includes an outlet for draining liquid out of the reservoir. The apparatus further comprises an outlet valve movable between a down position where liquid accumulates in the reservoir and a raised position where liquid accumulated in the reservoir is flushed out via the outlet. The outlet valve comprises a bottom portion sized and shaped to fit loosely in the outlet chamber when the valve is in the down position. The valve also comprises a float portion topping the bottom portion to move the valve in the raised position by buoyancy when a sufficient amount of liquid

is accumulated in the reservoir, thereby providing a passageway for liquid between the bottom wall of the reservoir and the valve leading to the outlet in the outlet chamber to flush liquid out of the reservoir. A guiding means is provided for guiding the outlet valve between the down position and the raised position.

- 5 The guiding means preferably comprises an upright rod with a lower end connected to a bottom wall of the outlet chamber, the valve being mounted on the rod in a slidable manner. Also preferably, the valve comprises a through hole spanning vertically within the valve for slidably receiving the rod.

- 10 The guiding means also preferably comprises a high stop mounted to the rod for preventing the valve from moving higher than the raised position.

Also preferably, the buoyancy flushing apparatus comprises a seal connected to an underside of the float portion of the valve to prevent seepage of liquid between the underside and the bottom wall of the reservoir when the valve is in the down position.

- 15 In accordance with a preferred aspect, the flushing apparatus comprises more than one of said outlets provided in the outlet chamber for distributing liquid in more than one direction.

The present invention also provides a buoyancy flushing apparatus for distributing liquid in more than one direction, comprising:

- 20 -a reservoir for accumulating liquid, having:  
    .an inlet for receiving liquid;  
    .an outlet chamber recessed in a bottom wall of the reservoir; the outlet chamber including more than one outlet for draining liquid out of the reservoir in more than one direction;

-an outlet valve movable between a down position where liquid accumulates in the reservoir and a raised position where liquid accumulated in the reservoir is flushed out via the outlets, the outlet valve comprising:

5 .a disc-shaped bottom portion sized and shaped to fit loosely in the outlet chamber when said valve is in the down position;

10 .a disc-shaped float portion having a larger diameter than the bottom portion and topping the bottom portion, to move said valve in the raised position by buoyancy when a sufficient amount of liquid is accumulated in the reservoir, thereby providing a passageway for liquid between the bottom wall of the reservoir and the valve leading to the outlets in the outlet chamber to flush liquid out of the reservoir, the passageway comprising a first portion extending underneath the float portion of the valve and leading to a second portion extending between the bottom portion of the valve and an inside wall of the outlet chamber; and

15 .a seal connected to an underside of the float portion to prevent seepage of liquid between said underside and the bottom wall of the reservoir when the valve is in the down position; and

-a guiding means for guiding the outlet valve between the down position and the raised position, the guiding means comprising:

20 .an upright rod with a lower end connected to a bottom wall of the outlet chamber, the valve being mounted on the rod in a slidable manner by means of a through hole spanning vertically within the valve; and

.a high stop mounted to the rod for preventing the valve from moving higher than the raised position.

25 The present invention is also directed to a method for flushing a predetermined amount of liquid, comprising the steps of:

- a) providing a flushing apparatus as defined above; and



- b) accumulating a sufficient amount of liquid in the reservoir to move the valve in the raised position and flush said amount of liquid out of the reservoir.

### BRIEF DESCRIPTION OF THE DRAWINGS

- 5 These and other objects and advantages of the invention will become apparent upon reading the detailed description and upon referring to the drawings in which:

Figure 1 is a perspective cross-sectional view of a buoyancy flushing apparatus according to a first preferred embodiment of the invention.

- 10 Figures 2 to 4 are cross-sectional side plan views of the flushing apparatus of figure 1 showing in sequence the steps occurring in one filling and flushing cycle of the apparatus, figure 2 showing the beginning of the cycle where the reservoir is empty, the outlet valve is in the closed position and liquid starts to accumulate in the reservoir.

Figure 3 is the same view as figure 2 showing the reservoir with an accumulation of water about to be sufficient to raise the outlet valve by buoyancy.

- 15 Figure 4 is the same view as figure 2 showing the outlet valve in the raised and open position thereby allowing the liquid accumulated in the reservoir to be flushed out via the passageway created between the valve and the bottom wall of the reservoir.

- 20 Figure 5 to 9 are cross-sectional plan views of a buoyancy flushing apparatus according to a second preferred embodiment of the invention showing in sequence the steps occurring in one filling and flushing cycle of the apparatus, figure 5 showing the outlet valve in the down and closed position at the point where water starts to fill the reservoir.

Figure 6 is the same view as figure 4, showing the float portion of the valve afloat over the water accumulated in the reservoir, the level of water being sufficient to cause the float portion to abut on the stop.

5 Figure 7 is the same view as figure 4, showing the bottom portion of the valve about to move upwards by buoyancy.

Figure 8 is the same view as figure 4, showing the valve in the raised and open position thereby allowing the liquid accumulated in the reservoir to be flushed out via the passageway created between the valve and the bottom wall of the reservoir.

10 Figure 9 is the same view as figure 4, showing the valve back in the down and closed position ready to start a new filling and flushing cycle.

While the invention will be described in conjunction with an example embodiment, it will be understood that it is not intended to limit the scope of the invention to such embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included as defined by the appended claims.

## 15 DESCRIPTION OF PREFERRED EMBODIMENTS

In the following description, similar features in the drawings have been given similar reference numerals and in order to weight down the figures, some elements are not referred to in some figures if they were already identified in a precedent figure.

20 Referring to figures 1 to 4, and in accordance with a first preferred embodiment of the invention, the buoyancy flushing apparatus (10) comprises a reservoir (12) for accumulating liquid (2), having an inlet (14), which consists in this case of the open top of the reservoir (12), for receiving liquid and an outlet chamber (16) recessed in a bottom wall (18) of the reservoir (12).

The outlet chamber (16) preferably includes more than one outlet (20) for draining liquid out of the reservoir (12) in more than one direction. Hence, this preferred embodiment is also advantageously suitable for distributing liquid in more than one direction. In this particular case, the outlet chamber (16) comprises four outlets (20) evenly distributed around the outlet chamber (16). It is however worth mentioning that the present invention also contemplates using only one outlet. In that latter case, the apparatus would be solely used as a flushing apparatus for dosing a certain amount of liquid before flushing the same.

Turning now also to figures 2 to 4, the flushing apparatus (10) further comprises an outlet valve (22) movable between a down and closed position, as in figures 2 or 3, where liquid (2) accumulates in the reservoir (12) and a raised and open position, as in figure 4, where liquid (2) accumulated in the reservoir (12) is flushed out via the outlets (20).

The outlet valve (22) comprises a bottom portion (24) and a float portion (25) topping the bottom portion (24). The bottom portion (24) is sized and shaped to fit loosely in the outlet chamber (16) when the valve (22) is in the down position whereas the float portion (25) is to move the valve (22) in the raised position by buoyancy when a sufficient amount of liquid (2) is accumulated in the reservoir (12), thereby providing a passageway (26), as shown in figure 4, for liquid (2) between the bottom wall (18) of the reservoir (12) and the valve (22) leading to the outlets (20) in the outlet chamber (16) to flush liquid out of the reservoir (12).

The bottom portion (24) fitting loosely in the outlet chamber (16) means that it does not tightly fit therein, thereby leaving a gap or passage for liquid between the valve (22) and the inside wall of the chamber (16).

As can be appreciated by viewing figure 4, the passageway (26) between the valve (22) and the bottom wall (18) of the reservoir (12) divides into a first and second portion

(26a, 26b). The first portion (26a) extends underneath the float portion (25) of the valve and leads to the second portion (26b) which extends between the bottom portion (24) of the valve (22) and the inside wall of the outlet chamber (16).

5 The valve (22) is preferably made of foam or any other suitable floatable material, that is to say a material with a density lower than the density of the liquid, as apparent to any person versed in the art. The float portion (25) could also consist of a hollow enclosed structure made of plastic or any other material that would allow the valve (22) to raise by buoyancy when a certain amount of liquid has been poured in the reservoir (12).

10 As shown in figure 1, the float and bottom portions (25, 24) are preferably disc-shaped and concentric, and the float portion (25) has a larger diameter than the bottom portion (24).

15 These two portions (24, 25) could be integral to each other and made of the same foam material. However, they preferably consist of two individual and independent portions, as clearly shown in the representation of the second preferred embodiment shown in figures 4 to 9. In other words, in operation, they simply abut on one another. In this way, it is easier to select the proper combination of material for the float portion (25) and bottom portion (24). This preferred embodiment gives more freedom of choice with regards to the material used and thus helps to better control the production cost of the apparatus. For example, the float portion (25) could be made of a floatable material  
20 whereas the bottom portion (24) could be made of a more dense material that would provide ballast properties to the bottom portion (24) when the valve (22) is in the down position and the liquid is filling up the reservoir (12).

25 It is however worth mentioning that these two individual portions (24,25) could be secured to one another , for example by bonding without departing from the scope of the present invention.

More preferably, the bottom portion (24) is made of a heavy foam whereas the float portion (25) is made of a light foam material.

It is indeed easy, for a person in the art, to adjust the weight of the float portion with respect to the water level required, or the dimension of the reservoir with respect to the volume of water required.

The outlet valve (22) further preferably comprises a seal (28) connected to the underside of the float portion (25) of the valve (22) to prevent seepage of liquid between valve (22) and the bottom wall (18) of the reservoir (12) when the valve (22) is in the down position. The seal (28) could be a rubber washer secured to the underside of the float portion (25) by bonding, screwing or any other type of fastening. The seal may further preferably comprises therein a material that prevents bacterial colonization, for example copper, or any polymer known in the art for their negative effects on bacterial growth. It is worth mentioning that, although a valve (22) without such sealing means would not perfectly prevent seepage of fluid when the valve (22) is in the down position, such valve (22) would not depart from the scope of the present invention.

Referring to anyone of figures 1 to 4, the flushing apparatus (10) also comprises a guiding means (30) for guiding the outlet valve (22) between the down position and the raised position. The guiding means (30) preferably comprises an upright rod (32) with a lower end (34) secured to the bottom wall of the reservoir (12), more precisely to the bottom wall (36) of the outlet chamber (16). The valve (22) is mounted on the rod (32) in a slidable manner by means of a through hole spanning vertically within the valve (22). Preferably, the guiding means (30) comprises a tubular sleeve (38) that receives the rod (32) and that is fitted in the through hole of the valve (22). The tubular sleeve (38) is made of a rigid material such as rigid plastic or metal, or any other rigid material that stands up to wear. As apparent to any person skilled in the art, the materials of the rod (32) and the sleeve (38) are chosen so as to obtain a good sliding relationship

between the sleeve (38) and the rod (32). Optionally, the rod (32) could be coated with a Teflon\* band. The sleeve (38), which helps reducing the friction, also helps preventing early wear of the valve (32).

5 As best shown in figure 4, the guiding means (30) comprises a high stop (40) mounted to the rod (32) for preventing the valve (22) from moving higher than the raised position under the effect of the buoyancy. As can be appreciated from figure 4, the velocity of the outflow through the outlets (20) can be adjusted by varying the height of the stop (40) on the rod (32). In this way, it is possible to obtain, if required, an important pulsed hydraulic event. The stop (40) may preferably comprise a ring (42) with a horizontal  
10 outer rim (44), slidable on the rod (32), and means such as a conventional fastener for removably securing the ring (42) to the rod (32).

The lower end (34) of the rod (32) is secured to the bottom wall (36) of the chamber (16) either by screwing, welding, bonding or any other way apparent to a person skilled in the art. Advantageously, the outlet chamber (16) may be provided in the bottom wall  
15 (36) thereof with a socket (46) to receive the lower end (34) of the rod (32).

The present invention also provides a method for flushing a predetermined amount of liquid, comprising the steps of a) providing a flushing apparatus (10) as defined above and b) accumulating a sufficient amount of liquid (2) in the reservoir (12) to move the valve (22) in the raised position and flush the amount of liquid out of the reservoir (12).

20 Preferably, the method comprises the step of c) repeating step b) of accumulating after the liquid has been flushed out.

The operation of the flushing apparatus (10) is illustrated with respect to figures 2 to 4. In figure 2, it can be seen that, at first, when no liquid (2) is accumulated in the reservoir (12), the valve (22) is maintained in a down position by gravity, thereby obstructing the  
25 outlet chamber (16). Then, as the liquid (2) accumulates in the reservoir (12), the gravity

effect is gradually counterbalanced by the buoyancy of the valve (22). As shown in figure 4, as the buoyancy force exceeds the gravity effect, the valve (22) raises, thereby providing a passageway (26) for liquid which discharges through the outlets (20) of the outlet chamber (16). While the liquid flows in the passageway (26), it also exerts an upward pressure on the valve (22), thereby further helping the same to remain in the raised position. When the reservoir (12) has been emptied, the valve (22) goes down to repeat another cycle.

Referring to figures 5 to 9, a second preferred embodiment of the invention is illustrated. In this particular case, the float and bottom portions (25, 24) of the valve (22) preferably consist of two individual parts which are interdependent. As can be best appreciated when viewing figures 5 and 6, in this preferred embodiment the tubular sleeve (38) is slidably mounted on the upright rod (32). Hence it can move from a lower position as in figures 5 to 7 to a higher position, as in figure 8. In this embodiment, the bottom portion (24) of the valve (22) and the high stop (40) are fixed to the tubular sleeve (38) whereas the float portion (25) is slidably mounted thereon. The seal (28) in this case is secured to the top face of the bottom portion (24). Consequently, when the water accumulating in the reservoir reaches a first level, as in figure 6, the float portion (25) moves upwards by buoyancy until it is stopped by the high stop (40). At this stage of the cycle, the valve (22) is still in a closed position, thanks to the bottom portion (24) and to the seal (28) which close the passage towards the outlets (20). Then the water which continues to accumulate in the reservoir starts to exercise an increasing upward pressure on the float portion (25). Consequently, the float portion (25) also exercises an upward pressure (P) on the high stop (40) which then causes the seal (28) to slightly lift off when the water accumulating in the reservoir reaches a second level, thereby allowing water to seep thereunder, as shown in figure 7. Then suddenly, the bottom portion (24) which is made of a floatable material is triggered off and moves upwards to abut on the float portion (25), thereby opening widely the passage (26) to the outlets (20), as shown in figure 8. When all the water which was accumulated in the reservoir

(12) has been flushed out, the valve (22) regains its down position as in figure 9, ready to start another cycle.

The apparatus of the present invention can be very useful in the field of septic systems as it allows an easy dosing of the effluent from a septic tank into an absorption field. It  
5 could also be very useful in any other systems involving very low flow rate of liquid , as in irrigation systems.

It is well known in the field of septic systems that, because the rate of flow of liquid into the septic tank is relatively slow, on the order of less than about one five liter per minute, the effluent is not effectively distributed throughout the absorption field.  
10 Experience has shown that an absorption field will progressively clog as a result of this poor distribution of the effluent. By accumulating the water coming from a septic tank before it is flushed out in the absorption field, the flushing apparatus of the present apparatus provides a pulsed feeding that helps reducing the clogging effect commonly occurring in the absorption field. The flushing apparatus also has the advantage of not  
15 requiring an important variation of the water level in order to obtain a pressure head sufficient to create the required hydraulic event at the outlets (20) of the apparatus (10). In other words, the pressure head created by the water accumulated in the reservoir (12) is more important than the variation of the water level necessary to create such pressure head. Therefore, in order to obtain an outflow comparable to the outflow  
20 obtained with a prior art buoyancy flushing apparatus of the type described, for example, in US 5,290,434, the reservoir (12) of the present invention does not have to be as high in height as the tank described in that prior art US patent.

Furthermore, the preferred embodiment described above, which comprises a plurality of outlets, also has the advantage of providing a liquid distribution system that shows  
25 little variations between the flows of liquid flowing out from the different outlets (20) of the apparatus (10). Indeed, experimentation conducted by the applicant has proven that



these variations are generally less than 10%, and even less than 5% in certain cases. Furthermore, testing conducted with wastewater shows that there is substantially no clogging up of the outlets (20) with the passing of time since these outlets (20) are regularly washed up by the liquid flowing out of the reservoir (12) at a relatively high velocity. Indeed, the results obtained with wastewater show that the variations mentioned above remain steady with the passing of time.

Results of testing conducted on a flushing apparatus, as shown in figure 5, which was fed with residential wastewater

Results obtained with respect to the distribution of the flow rate between each outlets:

Duration of the test (in days)	Number of outlets	Deviations from the mean flow rate (%)	
1	4	-7,0	4,2
97	4	-5,5	3,0
	6	-4,8	4,4
144	4	-3,6	3,1
240	4	-2,1	1,7

Although preferred embodiments of the present invention have been described in detail herein and illustrated in the accompanying drawings, it is to be understood that the invention is not limited to these precise embodiments and that various changes and modifications may be effected therein without departing from the scope or spirit of the present invention.

**WHAT IS CLAIMED IS:****1. A buoyancy flushing apparatus comprising:**

-a reservoir for accumulating liquid, having:

5            .an inlet for receiving liquid;

          .an outlet chamber recessed in a bottom wall of the reservoir; the outlet chamber including an outlet for draining liquid out of the reservoir;

          -an outlet valve movable between a down position where liquid accumulates in the reservoir and a raised position where liquid accumulated in the reservoir is flushed

10        out via the outlet, the outlet valve comprising:

          .a bottom portion sized and shaped to fit loosely in the outlet chamber when said valve is in the down position;

          .a float portion topping the bottom portion to move said valve in the raised position by buoyancy when a sufficient amount of liquid is accumulated in the reservoir, thereby providing a passageway for liquid between the bottom wall of the reservoir and the valve leading to the outlet in the outlet chamber to flush liquid out of the reservoir, and

          - a guiding means for guiding the outlet valve between the down position and the raised position.

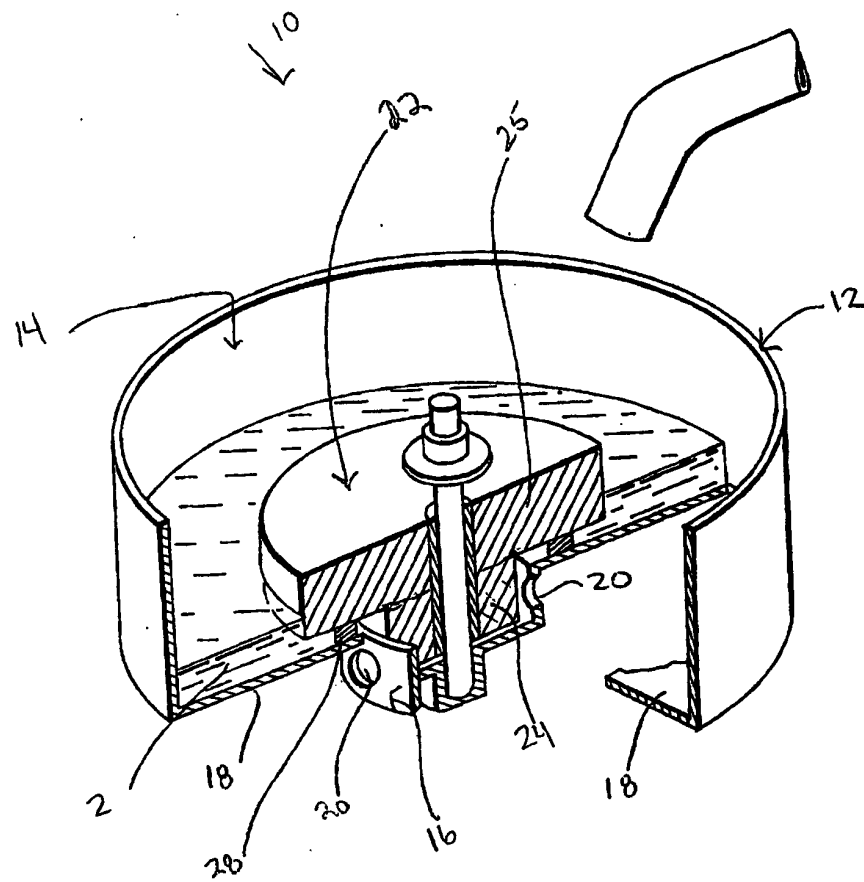


FIG. 1

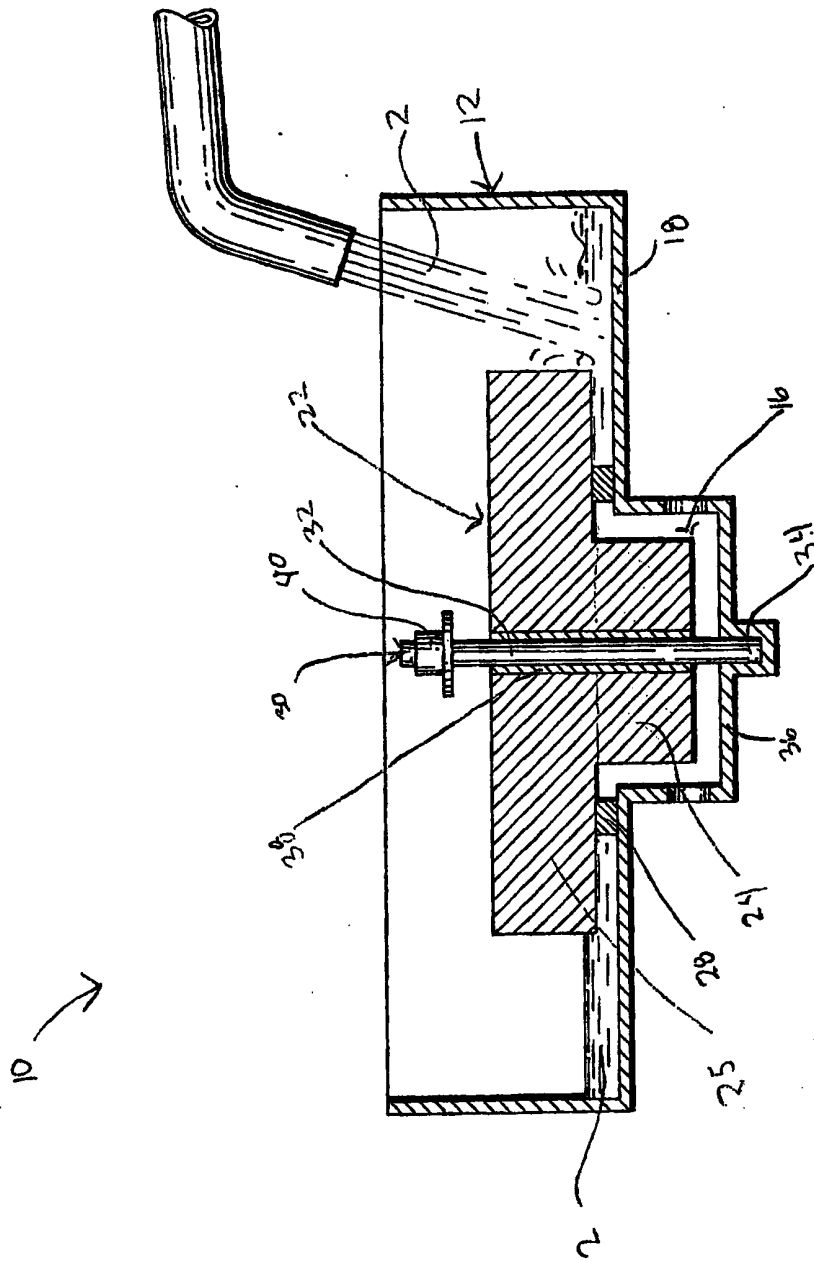


FIG. 2

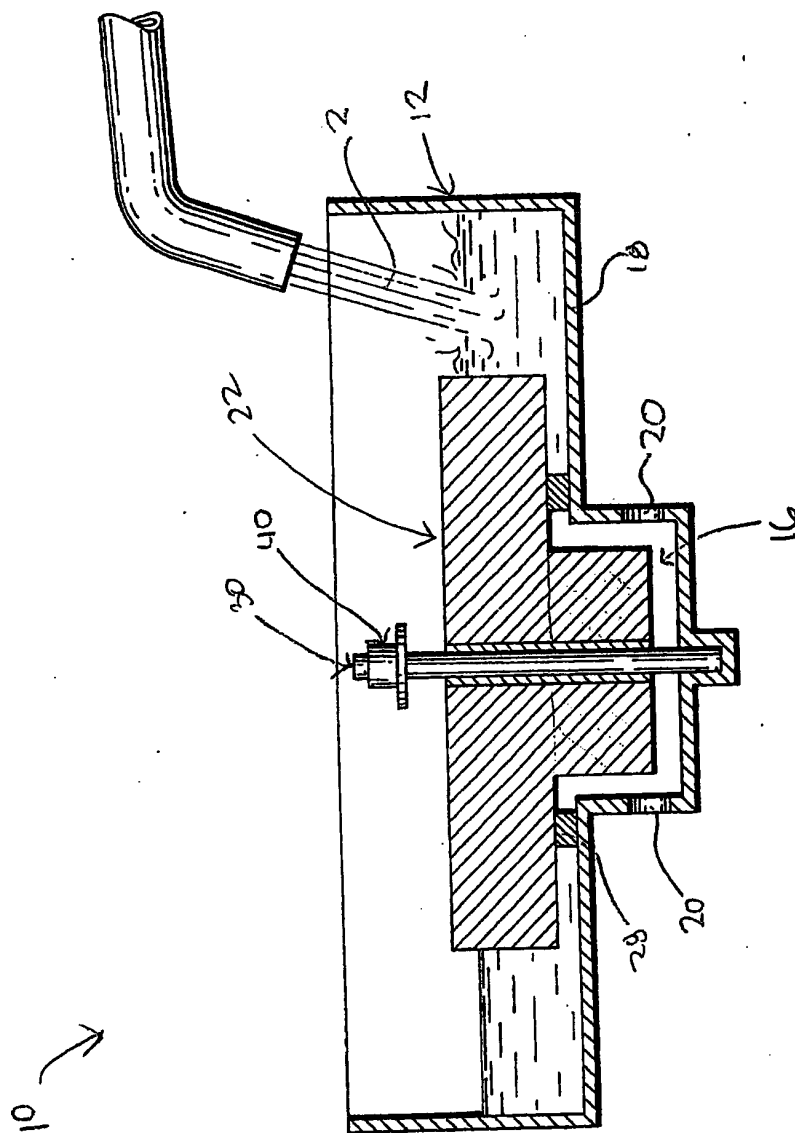


FIG. 3

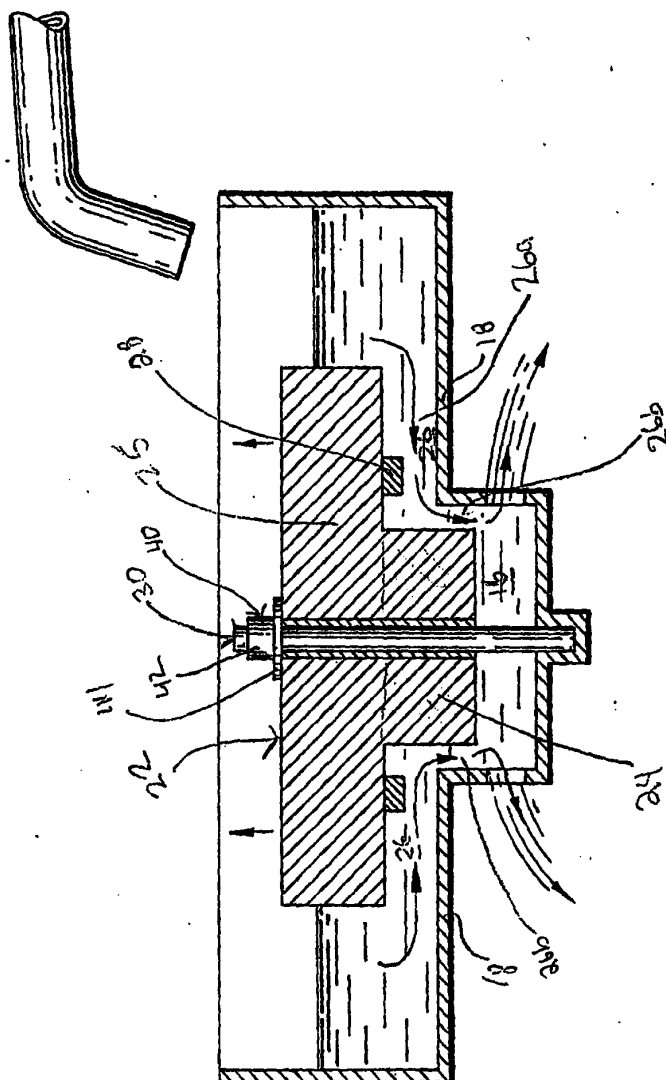


FIG. 4

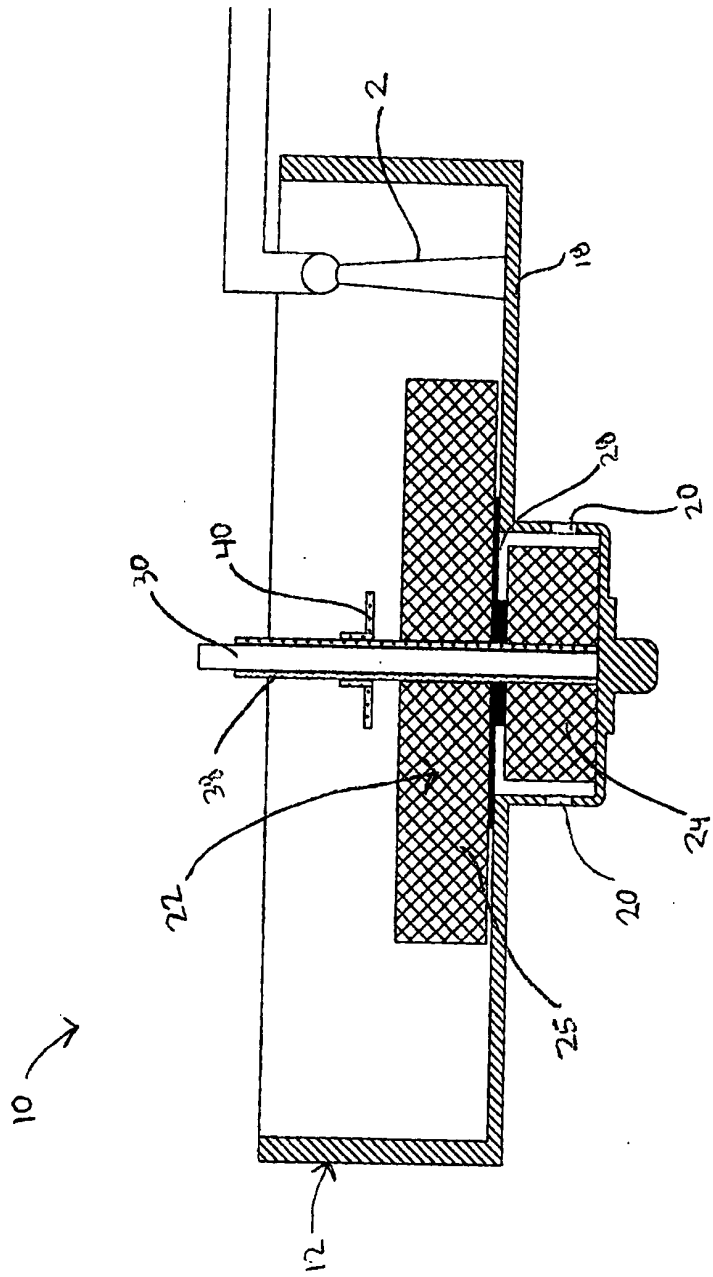


Fig. 5

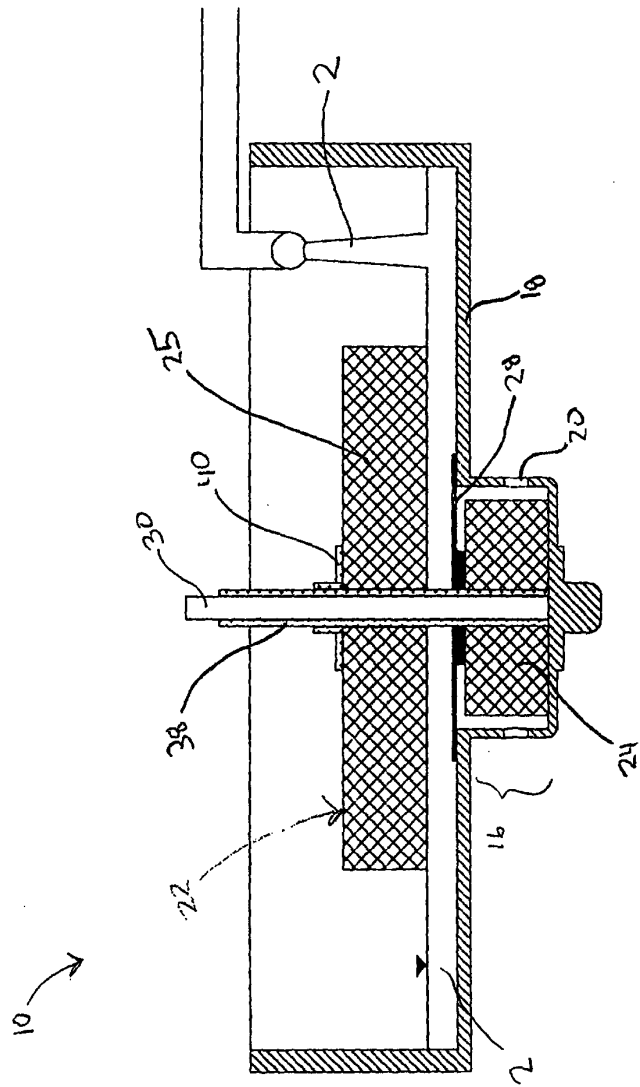


Fig. 6



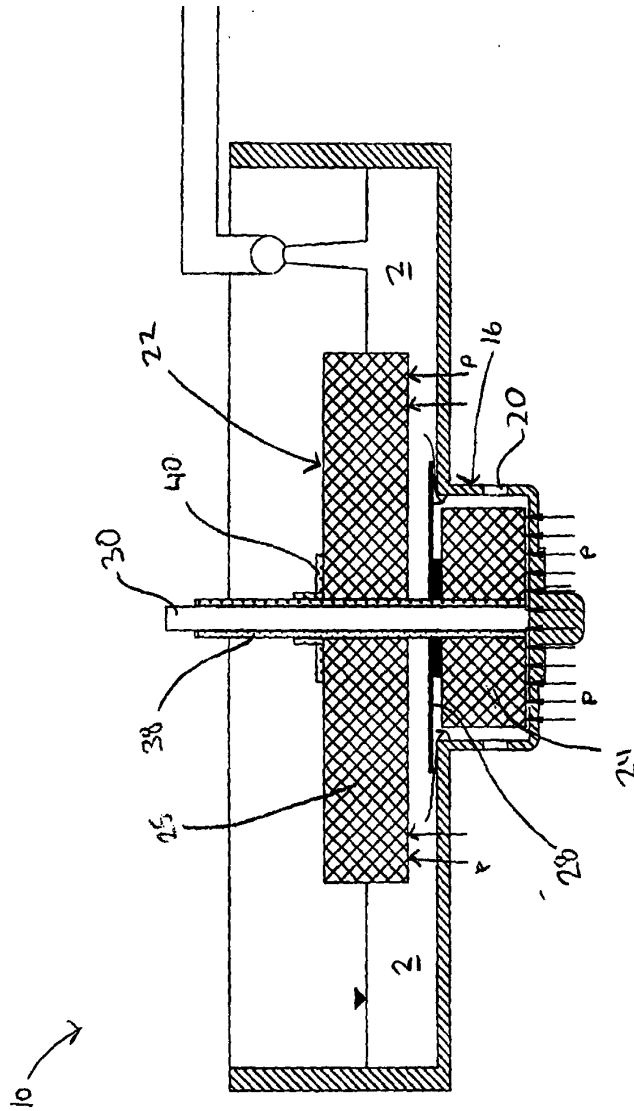


Fig. 7

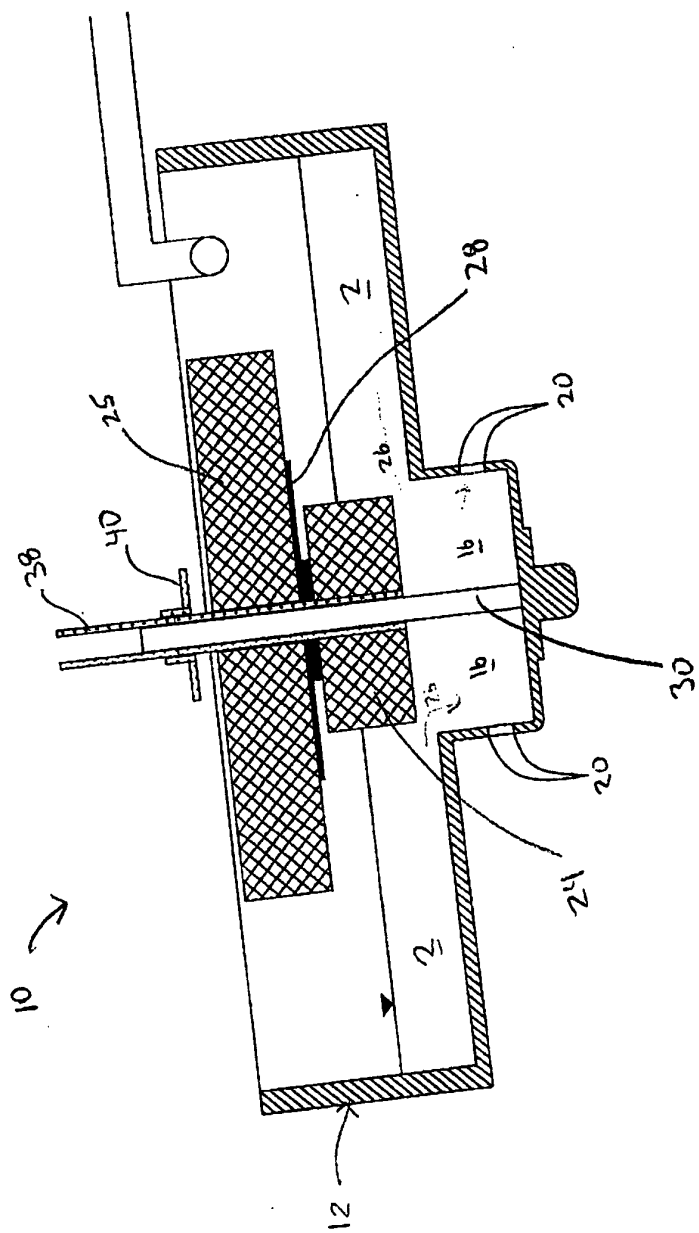


Fig. 8

